

REMARKS

Claims 1 - 16 remain active in this application. Claims 11 - 16 have been withdrawn from consideration as being non-elected, without traverse, in response to a requirement for restriction. Claim 1 has been slightly amended to make explicit the clear inference of the language of the claims as originally filed. Support for the amendments of the claims is found throughout the application, particularly in Figures 1 and 2 and the description thereof on pages 8 - 9. No new matter has been introduced into the application.

It is noted, for the record, that claims 11 - 16 have not been cancelled even though the present office action appears to indicate that only claims 1 - 10 are present. Claims 11 - 16 stand withdrawn from consideration and will be cancelled upon allowance of claims 1 - 10 or the filing of a divisional application containing the same. The indication of acceptance of the drawings filed March 12 , 2001 is noted with appreciation.

Claims 1 - 3 and 5 - 7 (and apparently claims 4 and 8 have been rejected under 35 U.S.C. §103 as being unpatentable over Venkatraman et al. in view of Drynan and claims 9 and 10 have been rejected under 35 U.S.C. §103 as being unpatentable over the same combination of references in view of the further teachings of Jain. These rejections are respectfully traversed, particularly in regard to the Examiner's assertions that claims referring to "PVD tungsten" constitute product-by-process claims.

Initially, it is respectfully submitted that it is well-recognized in the art that various materials will exhibit different physical properties depending on the process of their formation or treatment to which they may be subjected. For example, different techniques of deposition may yield different densities or porosities,

different crystal structures or grain textures and/or different degrees of isotropy in the deposition on surfaces of varying topology. Similarly, annealing is well-recognized to alter grain structure which may affect hardness and various electrical properties of a material. In the case of tungsten PVD tungsten is more dense than, for example, CVD tungsten and does not require nucleation for deposition as does CVD tungsten (with tungsten hexafluoride which attacks copper). Therefore, it is respectfully submitted that a term such as "PVD tungsten" should be substantively treated in much the same manner as a particular allotrope of any given material such as graphite or diamond and certainly does not and should not be regarded as necessarily justifying the treatment of a claim containing such a term as a product-by-process claim and certainly not for purposes of reducing the standard for making a *prima facie* demonstration of obviousness to shift the burden of proof of distinction to Applicants as to claims including such a recitation or other claims as it appears the Examiner may have contemplated. Accordingly, it is respectfully submitted that claims 1 - 10 are, in fact, claims to a structure rather than a product-by-process and should be treated as such.

Properly considered, the invention is a structure which provides a solution to particularly complex, intractable and multi-faceted problems of metallurgy and integrated circuit device layout at particularly high integration density as detailed in the "Background" section of the specification. Briefly summarized, copper is preferred at lower levels of wiring to provide reduced signal propagation time while aluminum is preferred at higher levels of wiring, particularly for connections by soldering and wire bonding where copper is less suitable due, for example, to the solubility of copper in solder materials.

Further, in regard to integrated circuit device layout, known structures for applying aluminum layers above copper layers have been large if formed as aluminum pads directly over copper pads and thus inconsistent with the formation of connection wiring in the same level. A smaller known structure such as a tungsten stud in a via has not been a practical alternative since CVD deposition of tungsten requires nucleation with tungsten hexafluoride which attacks copper and causes an unacceptable reduction in manufacturing yield. These problems are not addressed at all by the prior art applied by the Examiner and which do not, singly or in combination, teach or suggest the claimed structure or provide evidence of a level of ordinary skill in the art which would support a conclusion of obviousness.

Specifically Venkatraman et al. is directed to a dual damascene structure which includes a composite, layered metal conductor. The Examiner reads the claimed, respective copper and aluminum layers on layers 14 and 16 which are placed in contact with each other. Therefore, the structure disclosed by Venkatraman et al. is, at best (since the particular metals of these respective layers are not specified and Venkatraman et al refers to doping of layer 14 to improve electromigration characteristics and thus layer 14 is presumably aluminum), substantially that of the large pad structure alluded to above and admitted as known in the specification in the paragraph bridging pages 2 and 3. Thus, Venkatraman et al. teaches nothing more relevant to the claimed invention than the admitted prior art, if, indeed anything of relevance at all, since Venkatraman et al. is not concerned with the overlaying of copper metallurgy with aluminum metallurgy in devices of high integration density.

More importantly in regard to the claimed subject matter, however, it can be readily appreciated from

Venkatraman et al. that there is no location corresponding to the location of the claimed opening and certainly no need for a conductive stud formed in such an opening since the metal layers, as applied by the Examiner are in direct contact with each other (e.g. without an intervening layer in which the claimed "opening" and, in turn, the tungsten stud, can be formed, now made explicit by the above amendment). Further, the provision of such a layer would be contrary to the teachings of Venkatraman et al. since the two metal layers are provided for properly filling of the dual damascene recess which would be effectively precluded by an intervening layer including an opening and stud. See *In re Gordon*, 221 USPQ 1125 (Fed. Circ., 1984).

Drynan, while somewhat more similar to the structure claimed in teaching the formation of a tungsten stud including a barrier layer between two metal layers, is not concerned with the reliable formation of a small structure solving the metallurgical and layout problems of placing an aluminum layer above a copper layer. The function of the barrier layer 105 is not specified although titanium and titanium nitride are disclosed to be suitable. Thus, the combination of Venkatraman et al. and Drynan, even if properly combinable, does not answer the claim recitations of a *combination* of a tungsten stud with a barrier layer formed in an opening between respective locations on a copper layer and an aluminum layer. Further, these references do not provide evidence of a level of ordinary skill in the art which would support a conclusion of obviousness since they do not lead to an expectation of success in providing a structure allowing an aluminum layer to be placed over a copper layer at small size and high manufacturing yield or even address the desirability or problems of doing so.

Accordingly, it is clearly seen that the proposed combination of Venkatraman et al. and Drynan is clearly improper and clearly a hindsight reconstruction of the invention based on the present disclosure which still fails to answer the recitations of the claims. The Examiner admits that Venkatraman et al. does not disclose a stud in combination with metal layers but glosses over the fact that there is no need for a stud nor even any location corresponding to the claimed location for an opening or function a stud could perform. Further, the only motivation for modification of either reference is clearly found only in the present application while the references, particularly Venkatraman et al., teach directly away from the claimed subject matter considered as a whole.

These deficiencies in the basic combination of references is not reduced by the inclusion of Jain in the applied combination, as the Examiner has proposed in regard to claims 9 and 10. Like Venkatraman et al., Jain is a dual Damascene structure having no location or need for an opening in which a stud is formed. The Examiner apparently cites Jain only for the covering layer and does not assert any relevance to the remainder of the structure and, it is respectfully submitted there is and can be none for the reasons discussed above.

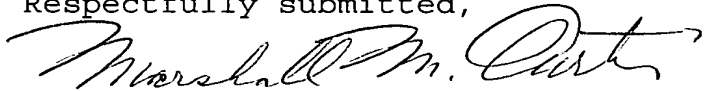
Therefore, it is respectfully submitted that the respective rejections of claims 1 - 10 are clearly in error since they rely on improper combinations of the respective teachings of the references and clearly evidence the utilization of impermissible hindsight while failing to address the subject matter of the claims as a whole. By the same token, it is respectfully submitted that the Examiner has failed to make a *prima facie* demonstration of obviousness of any claim in the application even by improperly considering claims as product-by-process claims as discussed above.

Accordingly, reconsideration and withdrawal of the rejections is respectfully requested.

Since all rejections, objections and requirements contained in the outstanding official action have been fully answered and shown to be in error and/or inapplicable to the present claims, it is respectfully submitted that reconsideration is now in order under the provisions of 37 C.F.R. §1.111(b) and such reconsideration is respectfully requested. Upon reconsideration, it is also respectfully submitted that this application is in condition for allowance and such action is therefore respectfully requested.

If an extension of time is required for this response to be considered as being timely filed, a conditional petition is hereby made for such extension of time. Please charge any deficiencies in fees and credit any overpayment of fees to Deposit Account No. 09-0458 of International Business Machines Corporation (E. Fishkill).

Respectfully submitted,



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PATENT TRADEMARK OFFICE